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27 Tests of Liberty Airplane Engine Submitted by the Air Service

In connection with an elaborate series of tests of American and foreign aeronautic motors, the Authorities at McCook Field submitted a Liberty airplane engine to the Bureau of Standards, for test in the altitude laboratory. Tests under ground conditions had been made at McCook Field, while at the Bureau the tests included runs with a fully opened throttle under conditions simulating those encountered at the ground and at various altitudes up to 25,000 ft., by steps of 5,000 ft.; propeller load runs every 5,000 ft. to 15,000 ft.; as well as temperature and friction horsepower runs at the ground and 15,000 ft. altitude. The results obtained have been computed and, in the case of tests made under ground conditions, are found to check very closely those obtained at McCook Field. The engine has been returned and will probably be installed in a plane and used as a means of determining propeller efficiency. The altitude laboratory is now being equipped for the installation of a 300 horsepower Hispano-Suiza engine for similar tests.

28 Ignition Systems for Internal Combustion Engines

For some time the Bureau of Standards has used a special form of calorimeter to measure the heat-per-spark of various ignition systems. While the heat-per-spark is by no means a direct measure of its actual igniting power, it does serve as an index of the total power output of any given system, and therefore forms a basis for the further study of the characteristics of ignition apparatus. This calorimeter has recently been reconstructed and recalibrated and heat-per-spark measurements on the Phillips-Brinton ignition system have been completed. Oscillographic tests on this system, are now in progress, by means of which the characteristics of the primary and secondary currents and voltages may be studied. A beginning has been made in the study of eddy currents in magnetos.

29 Aeronautic Instruments

In carrying out performance tests of airplanes in which, for example, the characteristics of a new type of plane are required to be known with considerable accuracy and detail, a permanent record of the readings of the more important instruments such as the altimeter, tachometer, air-speed indicator, radiator thermometer, and the pressure gages, is desired. At the request of the Engineering Division of the Army Air Service, a device involving a motion picture camera of special design is being prepared for use in photographing

the instruments on an instrument board illuminated by incandescent lamps. This will permit of obtaining permanent simultaneous records of the readings of these instruments at chosen intervals from 5 seconds to one minute, throughout the period of the test flight.

30 Wind Tunnel Investigations

The Bureau's Wind Tunnel staff has been occupied for some weeks on a series of tests of a multiplane airplane model, this being a land machine with several wings arranged in three groups in tandem, the fore and aft groups being biplanes, and the middle one a triplane. The work done involved the determination of the static longitudinal stability and the effect of certain changes in the model, such as alteration of the size of wings in the aft biplane group, and of the length of tail, on the stability. The span of the triplane wings of the full scale machine, which has been constructed, is 88 feet, and the power plant consists of three Liberty 12's. This work is being done at the request of the Air Service.

A wind motor for the driving of film cameras on airplanes was tested for the regulation performance of its speed controllers. This motor is essentially an air turbine, which is governed by dampers in the channel in which the motor is mounted. The tests included the determination of the relation between the rotational speed of the motor and the setting of the damper for several wind speeds. A bomb arming vane of the Semple type submitted by the Ordnance Department of the Army was mounted on a Mark I drop bomb in the wind tunnel, and determination made of the speed at which the firing pin was released, both for the forward and for the aft position of the vane with respect to the bomb.

Calibrations of a recording angle-of-attack meter, designed at the Bureau, were carried out. The work done at Lynn, Mass., on the determination of head resistance and pressure distribution of various types of projectiles in the exhaust flow of a high pressure air compressor is now being extended to the lower speed range obtainable in the wind tunnel of the Bureau.

31 Fireproof Airplane Wings

The Bureau has given general consideration to the possibilities in the way of production of fireproof airplane wings. It appears that a corrugated metal wing similar to the German Junker cannot be produced from sheet metal at present available, without exceeding greatly the weights now allowed for airplanes constructed either for the Army, Navy, or commercial concerns. Further investigations are in progress in the hope of securing a more suitable material.

As substitutes for the present fabric covering of wings,- thin sheet metal, sheet metal reinforced by wire mesh, and painted wire mesh are under investigation. The first seems to be excluded by reason of its low tearing resistance, while the addition of the wire mesh as reinforcement to enhance the tearing resistance seems to make a feasible construction, though experimental work is required to determine the best possible means of securing the sheet to the reinforcing mesh. Painted wire mesh is very resistant to fire, and seems to be a promising construction. Experiments are now under way to determine the best material, size of wire, and closeness of mesh, and a manner of applying the paint to secure the required strength and lightness, combined with a suitably smooth surface. In connection with the investigations of transparent wing construction, it has been found that such a provision will be useful only over a limited area near the fuselage. Experiments with available flexible transparent materials show that wire mesh and other reinforcements may be required to afford the desired strength.

32 Structural Parts for Navy Airplanes

Fifteen very large struts for flying boats were submitted to the Bureau for test, to the end of determining whether the designed strength was developed and whether any changes to produce the most efficient strut and spar could be suggested. Considerable variations in strength were exhibited by the specimens, in seeking the cause of which a hundred or more tests were run to determine the quality of the wood used in the construction of the various struts and spars. This showed that there was a wide variation in the mechanical properties of the material, and that a direct correlation existed between the strength of the struts and the mechanical properties of the wood, as those struts which developed the greatest strength were composed of material of exceptional quality. As a result of this investigation a complete report with recommendations and suggestions was submitted to the authorities requesting the test.

33 Measurement of Photographs

At the request of the Ordnance Department, the Bureau aided in an investigation of motion pictures of a falling bomb, these pictures being taken from an airplane over a body of still water. The reflected image of the airplane was easily distinguished in the film. Contrary to expectation, measurements could be made much more precisely on a positive print than on the original film, perhaps because of the difference in texture. It proved to be possible to measure on the image such dimensions as the length and diameter of a bomb and the wing spread of the plane, to .010 to .015 mm. The ballistics of the bomb as deduced from these

measurements check the theoretical values to a fraction of one percent, thus providing in a very inexpensive way accurate data on a subject of great importance.

34 Investigation of New Ordnance Process

To reduce the cost of manufacture, methods of manufacturing guns from a single forging by expanding under a very high internal pressure calculated to produce the required distribution of stress in the wall of the gun, have been devised, this process being known as "auto-frettage", which has been used abroad, particularly in France. At the request of the Ordnance Department of the Navy, a report was made upon certain methods of auto-frettage, including a critical study of the theory involved and of the probable changes which would occur in the metal due to its being over-strained. It is expected that the method will prove to be successful, but more experimental data are needed.

35 Investigation of Copper Crusher Cylinders

This investigation has been continued to include the effect of aging at 0°C and 100°C and of repeated applications of load only slightly exceeding the initial load of compression. In practice the copper cylinders are compressed at a loading somewhat below the estimated pressure in the gun, this pre-compressed cylinder then being used to determine the pressure developed upon firing. Possible dimensional changes in storage, which may last for several years, are being investigated during the aging process. In practice the change in dimensions of the pre-compressed cylinder is taken as an index of the additional pressure to which the cylinder is subjected, e.g., if compressed at 38 000 lb. per sq. in. and fired at 44 000 lb. per sq. in. The tarage table from which this value of the gun pressure is determined is based upon the assumption that only the additional 6 000 lb. per sq. in. (44 000 - 38 000) is effective in producing the increment of change in dimensions. Experimental work has indicated that this is far from a correct assumption.

36 Armor Plate Steels

A study of special steel for armor plate is still requiring the time and attention of several members of the Metallurgical Division in cooperation with the Navy Department, which has arranged for the machining of the plates. Twenty-one finished and treated plates were shipped to the proving grounds for ballistic tests.

Respectfully,

S. W. STRATTON

Director
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